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User's Guide

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Agilent E2695A SMA Probe Head for InfiniiMax 1130 Series Active Oscilloscope Probes

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Agilent E2695A SMA Probe Head

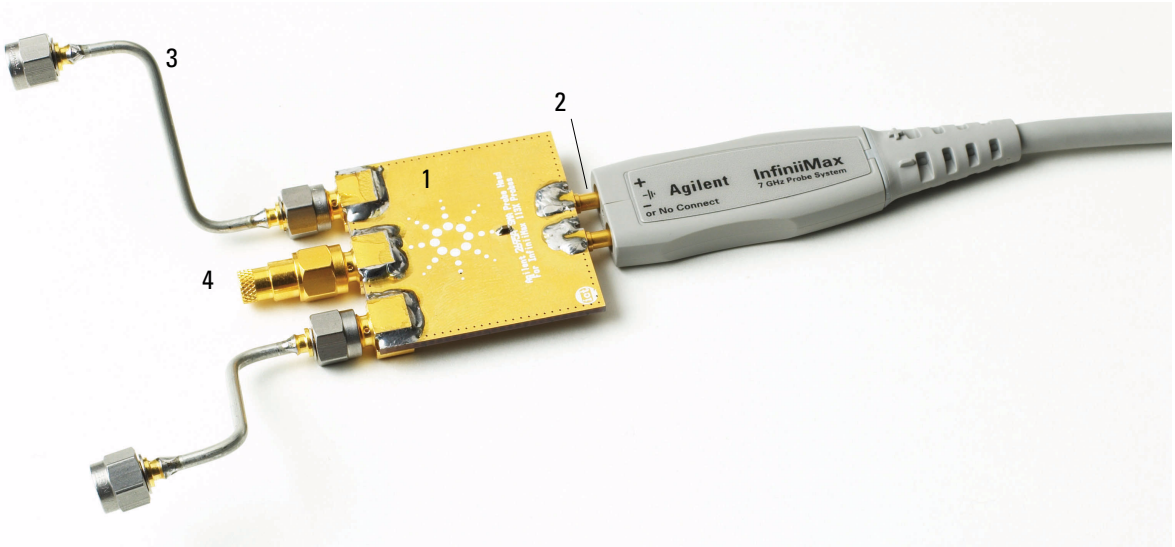
The Agilent E2695A SMA Probe Head allows an easy and high performance way to connect differential (or single-ended) signals that exist on SMA connectors to Agilent InfiniiMax 1130 series oscilloscope probes. Signals that exist on other types of 50 Ω connectors can be connected using appropriate adaptors. Advantages of this solution are:

- When measuring differential signals only one channel of the oscilloscope is used.
- Short closely matched 0.086 in semi-rigid coax can be used on the inputs which means that differential de-skew isn't needed unless the signals are skewed at their SMA connectors.
- Probe cable loss is compensated. Conventional cables used to connect signals to the oscilloscope inputs are not compensated. Cable loss can be a very significant contributor to jitter!
- Common mode rejection is better than using channel subtraction in oscilloscope.
- Termination network can be customized to accommodate different standards or needs including supplying a bias voltage to the termination point.
- Avoids probe loading effects since input is a well matched 50 Ω termination.

Description

A picture of the E2695A SMA probe head connected to an 1134A probe amp is shown in Figure 1. The probe head consists of a pc board with SMA connectors on one side and GPO connectors on the other side. The two outside SMA connectors are for input signal connection and the center SMA connector can be used to provide a dc bias for the termination or to view the common mode signal. The GPO connectors are designed to plug directly into the input of an 1130 series probe amplifier using GPO-F to GPO-F adaptors that are designed to stay with the pc board. The signal inputs come with short matched 0.086 in semi-rigid SMA cables that are formed in an offset configuration so that the spacing between the connection points can be easily adjusted. The center SMA connector for the termination point has an included 50 Ω terminator attached.

Figure 1



E2695A SMA Probe Head with 1134A Probe Amplifier

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Included Parts

Item	Description	Quantity
1	Probe Head PC Board	1
2	GPO-F to GPO-F adaptor	2
3	SMA-M / SMA-M cables	2
4	50 Ω terminator	1

Recommended Accessories

Description	Manufacturers Part Number
SMA Coaxial DC Block	Inmet # 8037
SMA 6 dB Coaxial Attenuator	Inmet # 18AH-6
SMA 12 dB Coaxial Attenuator	Inmet # 18AH-12
SMA Adjustable Delay	ATM Microwave #P1907

Replacement Parts

Description	Quantity	Manufacturers Part Number
GPO-F to GPO-F adaptor	2	Corning Gilbert # A1A1-0001-03 Rosenberger # 19K 109-K00 E4
SMA-M / SMA-M cables	2	Agilent E2695-61601
50 Ω terminator	1	Agilent E2655-87601

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SMA Probe Head Schematic

A schematic for the SMA probe head is shown in Figure 2. It is important to understand the schematic especially if the input or termination network is to be customized or driven with a bias voltage. The SMA probe head is shipped as shown in the schematic. Note that the 0.6 pF variable capacitors are factory adjusted for low frequency flatness and shouldn't need to be adjusted unless they are accidentally disturbed. All SMT components except variable capacitors are size 0603 (0.060 in x 0.030 in). Optional configurations that might be desired are:

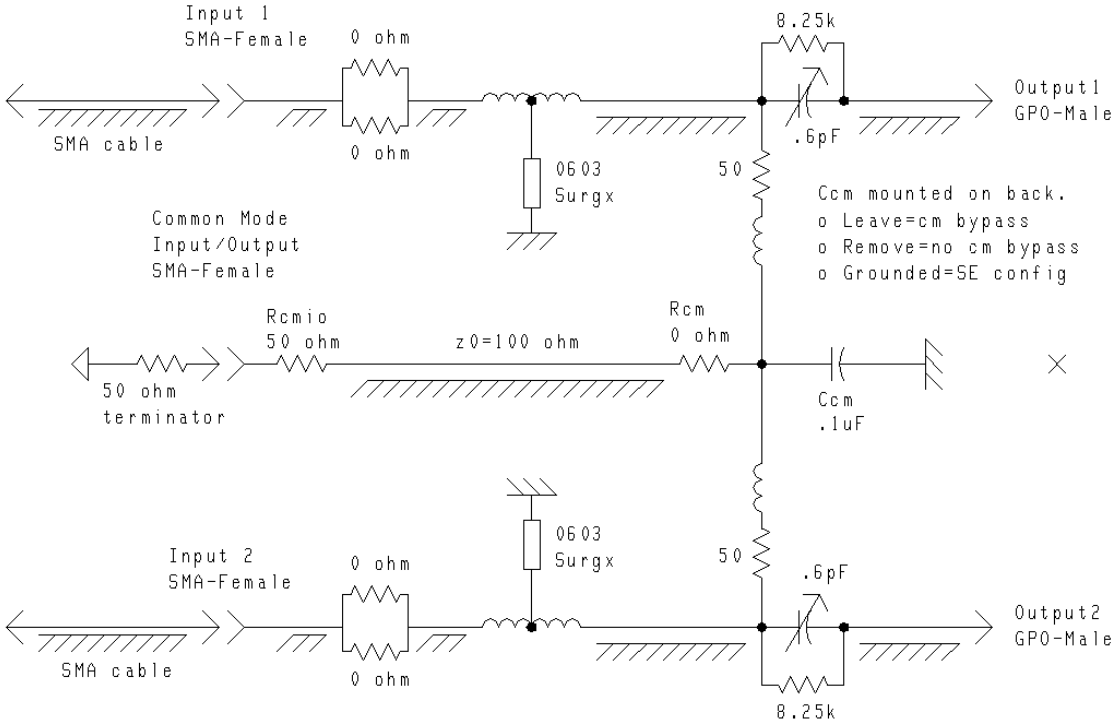
- DC block on input. If it is desired that the input dc voltage be blocked by using ac coupling, the zero Ω resistors on the input lines can be removed and replaced by capacitors. This allows the corner frequency of the dc block to be customized for the application. Note that two capacitors of one half the desired value should be used to replace the zero Ω resistors, and should be attached along the edges of the input transmission line. This is done to limit parasitic inductance and maintain performance.

If zero Ω resistors are replaced by dc blocking capacitors, the probe calibration cannot be done and default calibration factors should be used.

- Common termination point to ground. If it is desired that the common termination point (where Rcm and Ccm are attached) be connected to ground then the pad that Ccm is attached to can easily be solder bridged to the ground around the pad. Note that Ccm is on the back side of the pc board.
- Common termination point to bias voltage. If it is desired to have the common termination point at a bias voltage, then the common mode input/output SMA port can be driven with a power supply. As long as Ccm is still used the port match looking into the power supply should not be an issue. Rcmio, Rcm, and Ccm can be modified as desired for bias application.
- Viewing of common termination point. You can use the common mode input/output port to view the common mode component of the differential input signal. To do this connect a 50 Ω oscilloscope channel to the common mode input/output port and configure pc board for Rcmio=50 Ω, Rcm=0 Ω, and remove Ccm. The bandwidth of this connection will be limited to ≅ 5.3 GHz because of the compound RC-RL termination network, but still may be useful for many signals. If desired Rcm can be customized to form a resistive divider and change the gain and load impedance to the common termination point.

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Figure 2



SMA Probe Head Schematic

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Performance Characteristics

E2695 Probe Head and InfiniiMax 1130 Series Probe Amp

Bandwidth (-3 dB) with	1134A	> 7 GHz
	1132A	> 5 GHz
	1131A	> 3.5 GHz
Rise and Fall Time (10% to 90%)	1134A	62 ps
	1132A	86 ps
	1131A	100 ps
Oscilloscope and Probe System		
Bandwidth (-3db)	1134A with 54855A	6 GHz
	1132A with 54854A	4 GHz
	1131A with 54853A	2.5 GHz
	1131A with 54846A	2.25 GHz
Input Return Loss (S11)	< 1 GHz	< -28 dB
	1 GHz to 4 GHz	<- 15 dB
	4 GHz to 7 GHz	< -10 dB
Input TDR (100pS step)	< 4%	(See note 5)
Input Resistance	50 Ω ± 1%	(See note 5)
Input Dynamic Range	± 0.83 V Differential or Single-ended	
Input Common Mode Range	± 2.24 V	dc to 100 Hz
	± 0.42 V	> 100 Hz
Maximum Signal Slew Rate	6 V/ns	Single-ended input
(SRmax See note 3)	10 V/ns	Differential input
(SMA attenuator can extend range. See note 4)		
DC Attenuation	3.3:1 ± 3% before calibration on scope	
	3.3:1 ± 1% after calibration of scope	
Zero offset error referred to input	< 15 mV before calibration on scope	
	< 3 mV after calibration on scope	
Offset Range	± 2.5 V	When probing single-ended signals
Offset Accuracy	< 3% of setting before calibration on scope	
	< 1% of setting after calibration on scope	
Noise referred to input	1.0 mVrms	
Propagation Delay	≅ 6.15 ns	

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Maximum Input Voltage	3.3 Vrms	Non-destructive voltage on each input to ground
ESD Tolerance	> 8 kV from 100 pF, 200 Ω HBM	

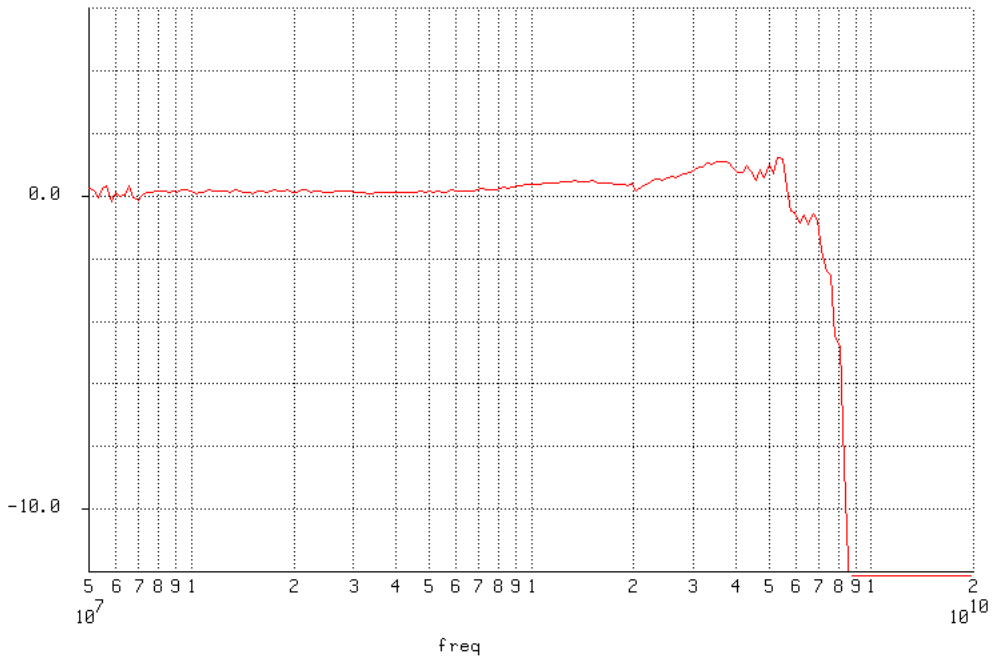
Notes

1 All characteristics are with probe head configured as shipped except as noted.
2 Values are for SMA Probe Head and probe amplifier
3 Srmax of sine wave = amplitude x 2 x π x frequency OR Srmax of a step ≅ amplitude x 0.6 / trise (20 to 80%).
4 Use of X:1 SMA coaxial attenuators in front of SMA Probe Head will:
   a. Increase by X the max input signal slew rate, dynamic range, offset range, common mode range, noise referred to the input, DC attenuation, and maximum input voltage.
   b. Most likely improve return loss and input TDR if attenuators are high quality
   c. Not affect bandwidth and rise time if attenuators are high quality.
5 Measured with common termination point solder bridged to ground since measured single-ended. This more closely matches the differential case where the common termination point is an ideal ground.

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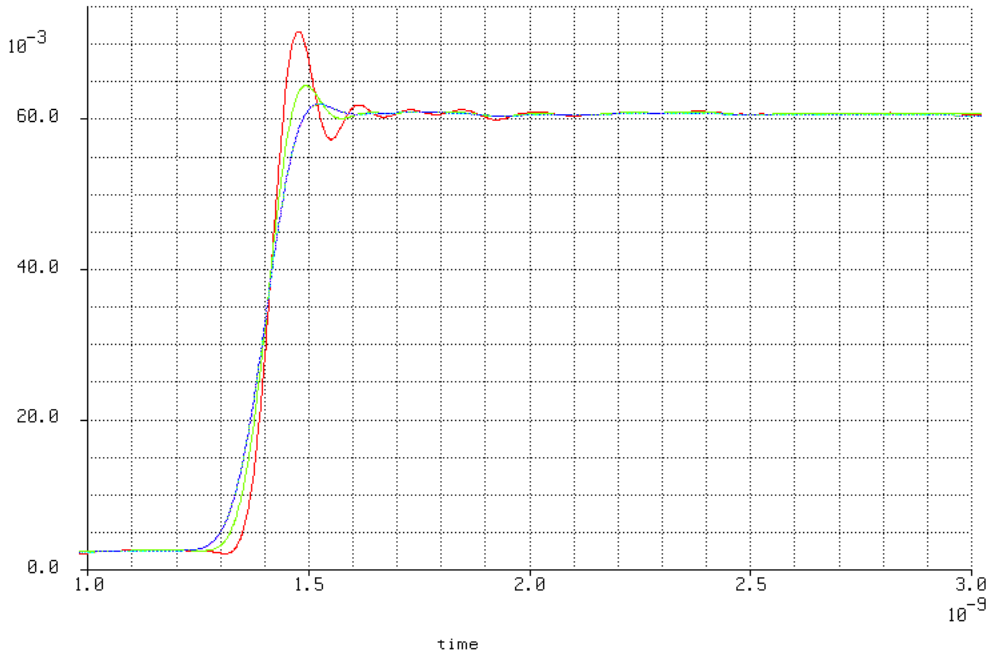
Performance Graphs

Figure 3



Frequency Response of E2695A with 1134A Probe Amp (Bandwidth on graph ≅ 7.5 GHz)

Figure 4



Time Response of E2695A with 1134A Probe Amp

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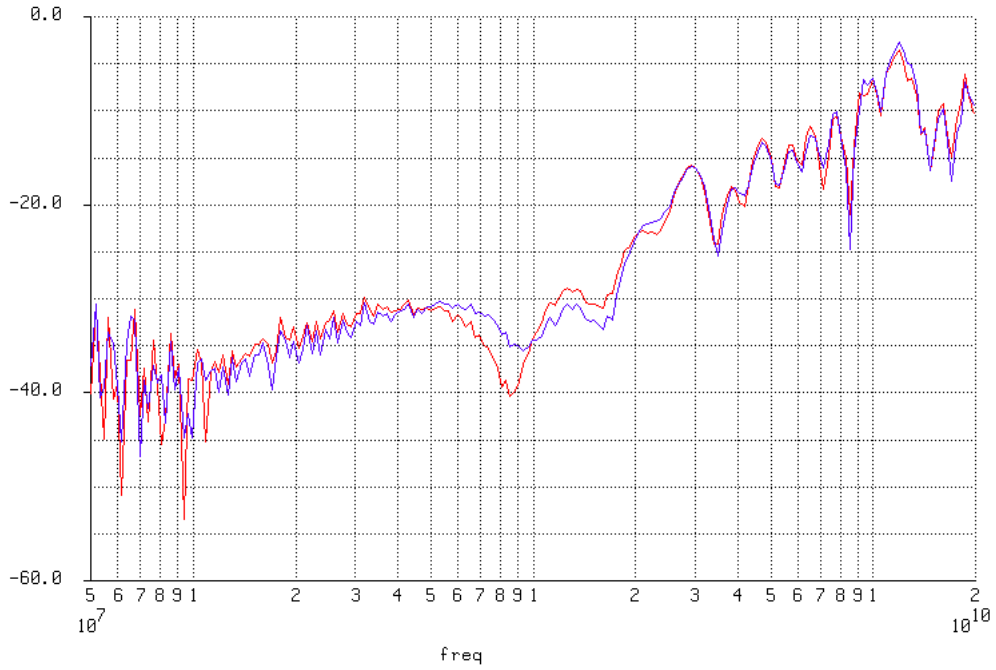
Notes for Time Response Graph

- Red step is probe output when input is a 35 ps step. Probe output rise time measures 71 ps. The step response rise time of the probe is therefore approximately equal to .

$$\sqrt{71^2 + 35^2} = 62\text{ps}$$

- Green step is probe output when input is a 100 ps step. Probe output rise time measures 103 ps.
- Blue step is probe output when input is a 140 ps step. Probe output rise time measures 135 ps.

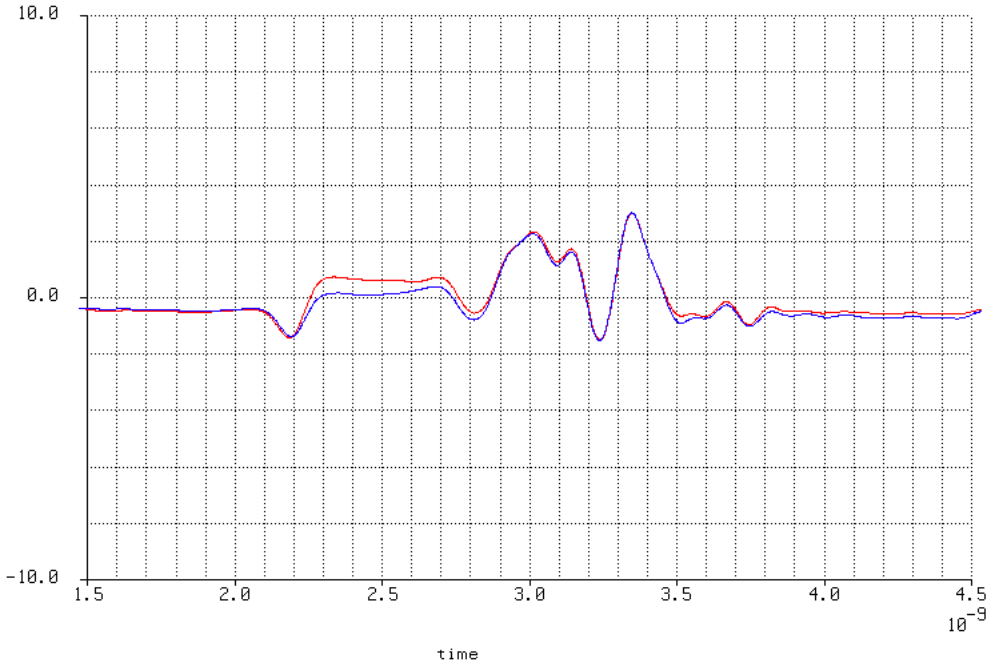
Figure 5



Input Return Loss S11 of E2695A with 1134A Probe Amp

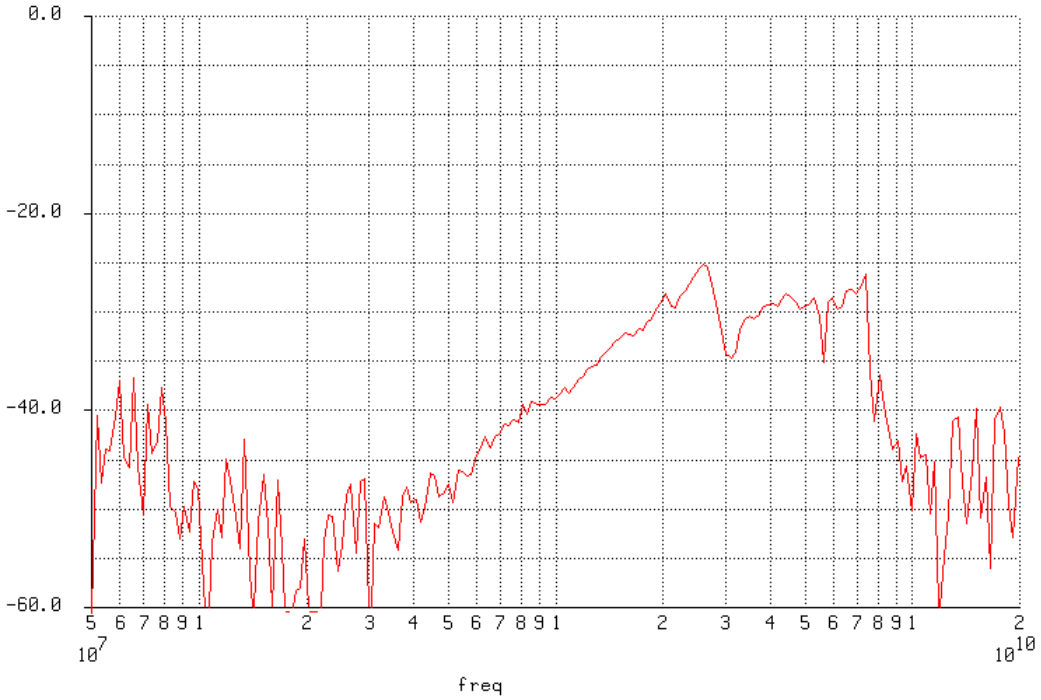
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Figure 6



Input TDR of E2695A with 1134A Probe Amp (TDR step is 100pS 10-90%) (Vertical scale is 2%/division)

Figure 7



Common Mode Response of E2695A SMA Probe Head with 1134A Probe Amp

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Usage Notes for E2695A SMA Probe Head

- When calibrating the SMA probe head on an Agilent Infiniium oscilloscope, un-plug the probe amp and plug it back in such that only the + side is connected to the side of the probe head that goes to the calibrator output. This is necessary to keep the cal signal from being applied in common to the both inputs of the probe amplifier.
- If the input signal's amplitude or slew rate exceeds the specification of the E2695A then external coaxial attenuators should be used. However, the 10 V/ns maximum slew rate of the E2695A is adequate to handle most high speed signal standards. As an example, a 1.6 Vp-p signal with a 100 ps rise time measured at the 20-80% points has a maximum slew rate of

$$\frac{1.6\text{V} \times 0.6}{100\text{ps}} = 9.6\frac{\text{V}}{\text{ns}}$$

  which is within the probe head's ability. An example of a coaxial attenuator is listed in the recommended accessories section.
- If it is desired to DC block the input without customizing the surface mount parts on the pc board, external coaxial DC blocks can be used on the input lines. An example of a coaxial dc block is listed in the recommended accessories section.
- If longer 50 ohm cables are used on the input lines they should be matched to within ≅ ±7 ps to minimize the impact of skew up to the 7 GHz bandwidth. If this level of matching can't be accomplished then coaxial 50 Ω trombone style variable delays should be used to match electrical lengths. See recommended accessories.
- The back mounted capacitor Ccm does expose the common termination node. Care should be taken to insure this point is not shorted or capacitor is not knocked off.
- The GPO-F to GPO-F adaptors that connect the probe head to the probe amp are designed to stay with the probe head since the GPO-M connectors on the probe head pc board are full-detent connectors. If for some reason the adaptor stays with the probe amp, remove it and plug it back into the probe head.
- For use on single-ended signals the common termination point should be connected to ground by solder bridging the pad for Ccm to ground. Additionally it is best to un-plug the probe amplifier and then plug it back in such that only the + input of the probe amp is connected to the side of the probe head to which the single-ended signal is connected.

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